



Optical Amplification

Source: Master 7_5



Optical Amplifiers

An **optical amplifier** is a device which amplifies the optical signal directly without ever changing it to electricity. The light itself is amplified.

Reasons to use the optical amplifiers:

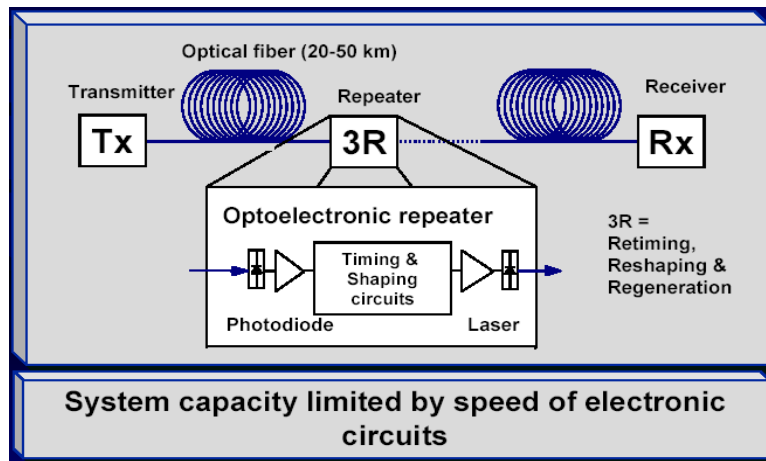
- Reliability
- Flexibility
- Wavelength Division Multiplexing (WDM)
- Low Cost

Variety of optical amplifier types exists, including:

- Semiconductor Optical Amplifiers (SOAs)
- Erbium Doped Fibre Amplifiers (EDFAs) (most common)

Traditional Optical Communication System

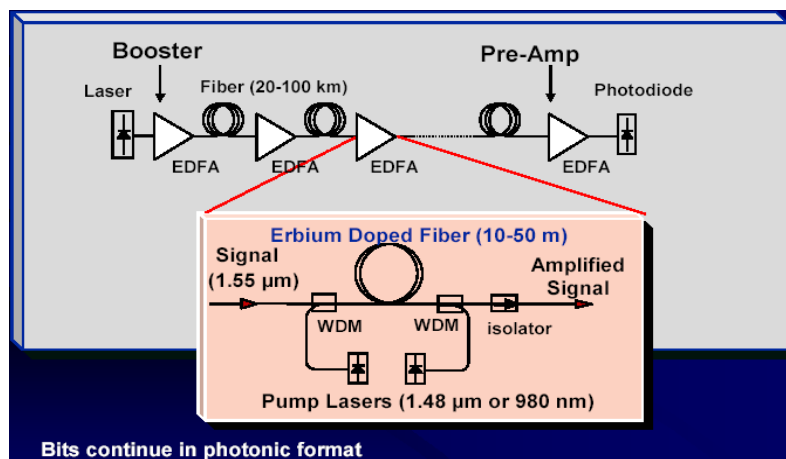
Loss compensation: Repeaters at every 20-50 km



H. Fragnito UNICAMP – IFGW

Optically Amplified Systems

EDFA = Erbium Doped Fibre Amplifier



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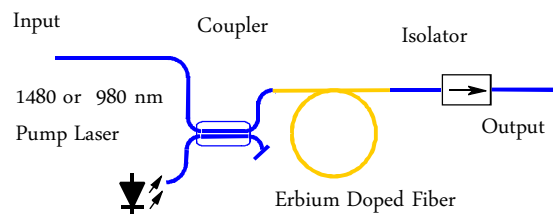
Optical Amplification

- Variety of optical amplifier types exist, including:
 - Semiconductor optical amplifiers
 - Optical fibre amplifiers (Erbium Doped Fibre Amplifiers)
 - Distributed fibre amplifiers (Raman Amplifiers)
- Optical fibre amplifiers are now the most common type
- One of the most successful optical processing functions
- Also used as a building block in DWDM systems

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Basic EDF Amplifier Design

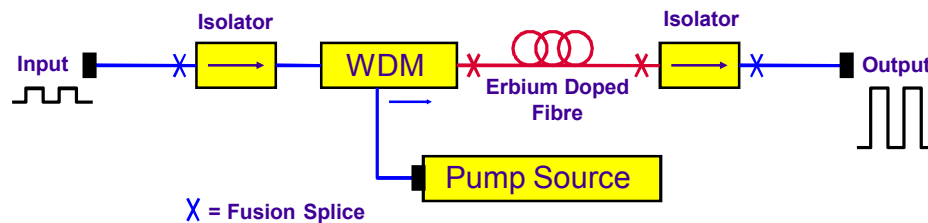
- Erbium-doped fiber amplifier (EDFA) most common
 - Commercially available since the early 1990's
 - Works best in the range 1530 to 1565 nm
 - Gain up to 30 dB (1000 photons out per photon in!)
- Optically transparent
 - “Unlimited” RF bandwidth
 - Wavelength transparent





Erbium Doped Fibre Amplifier

- A pump optical signal is added to an input signal by a WDM coupler
- Within a length of doped fibre part of the pump energy is transferred to the input signal by stimulated emission
- For operation circa 1550 nm the fibre dopant is Erbium
- Pump wavelength is 980 nm or 1480 nm, pump power circa 50 mW
- Gains of 30-40 dB possible



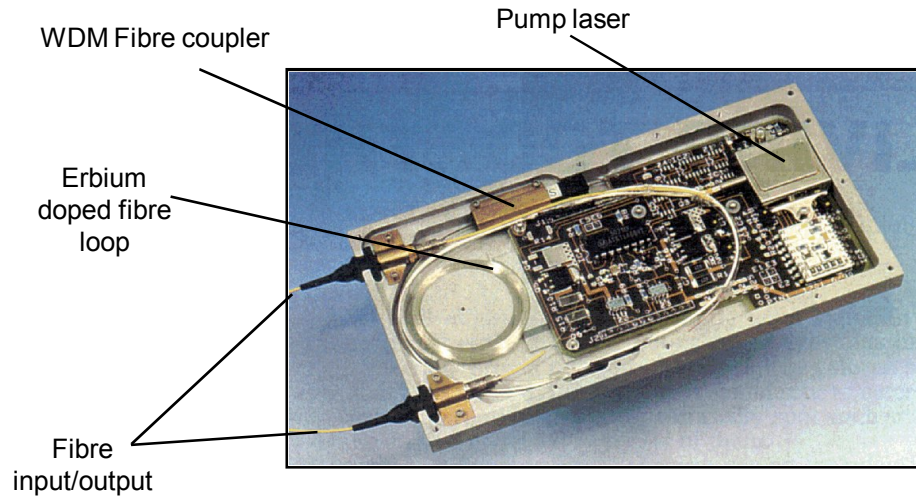
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Basic principle of EDFA

A relatively high-powered beam of light is mixed with the input signal using a wavelength selective coupler. The input signal and the excitation light must be at significantly different wavelengths. The mixed light is guided into a section of fiber with erbium ions included in the core. This high-powered light beam excites the erbium ions to their higher-energy state. When the photons belonging to the signal at a different wavelength from the pump light meet the excited erbium atoms, the erbium atoms give up some of their energy to the signal and return to their lower-energy state.

Interior of an Erbium Doped Fibre Amplifier (EDFA)



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Operation of an EDFA

